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VOYENNAYA MYSL' [MILITARY THOUGHT] No. 7, July 1986, pp. 31-40

Problems of Air Support for Troops
(From materials in the foreign press)

by

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Close air support for troops consists of combat actions in support of the formations (or large units) of ground forces in an operation (or battle). It is carried out by the forces of front (tactical) and army aviation in order to destroy the enemy's conventional and nuclear weapons, his strongpoints, second echelons and reserves, command and control posts, and other targets. Its main principles were determined by synthesizing the experience of combat actions. These include: close cooperation between aviation and ground forces at the tactical level, timely performance of missions, continuity of support, and strict coordination of air and ground attacks on the battlefield.

The forms and methods of implementing these principles in theory and practice have their own specific features in the Soviet art of warfare and in the armies of the NATO countries. These are examined in this article by taking into account the experience of local wars and the methods for the combat employment of the US Air Force in them. This experience must be approached critically, but it cannot be ignored when working out key questions of the operational art and tactics of the Soviet air forces.

Close cooperation between aviation and ground forces at the tactical level. Close air support is distinguished not only by the power of fire strikes but also by continuous coordination of the efforts of air force units and subunits with those of ground force units and large units. Foreign specialists believe that the success of their joint operations depends to a considerable degree on the unity of views of the officers taking part in the planning, preparation, and conduct of the joint operations.*

* Truppenpraxis, No. 8-9, 1966, p. 600.

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The organization of cooperation between aviation and ground forces in a combined-arms operation has followed a definite path of development. For example, in the war in Vietnam the US Army command strove to have constantly subordinated to it both air support as well as all other combat support weapons. This was based on the goal of facilitating the organization of cooperation and the arrangement of contacts between representatives of the Army and Air Force. However, after testing the feasibility of a proposed table of organization and equipment, only army aviation (helicopters and auxiliary aircraft) was directly subordinated to the Army. All tactical combat aircraft, including ground-attack aircraft, remained with the Air Force. When preparing for combat operations it was stipulated that there would be allocated to an army corps commander (or army commander) the resources in the form of aircraft sorties for the day or for the period the operation would be conducted. The principle of joint command and control, which had existed before the war, was thus maintained: the combined-arms commander assigned a support mission (within the limits of the allocated resources) through the aviation representative, who was responsible for preparing the sortie and for its results. This method for the command and control of aviation survived the test, despite friction at all levels of cooperation, and especially at the tactical level. Difficulties in organizing air support had the following causes.

First, the commanders of combined-arms units who had been granted authority to call for aviation often assigned it targets whose destruction achieved only momentary success and had little effect on the overall outcome of the battle. Combat aircraft were employed in the role of long-range artillery, which made the cost of an air strike much greater than its effectiveness. Aviation's contribution to the overall goal proved insignificant.

Second, high-cost aviation resources were used up at excessively rapid rates. Frequently a combined-arms commander had nothing to call on at the decisive stage of a battle, since the scheduled support had already been provided and there were no remaining reserves. The principle of economizing on aviation resources in ratio to other weapons of destruction was poorly adhered to.

Third, for aviation the frequent shifts of combat missions (or strike targets), which allegedly were dictated by "requirements" of the battle, were unacceptable. After receiving an order indicating the target coordinates and description, readjusting to an alternative target was usually undesirable and sometimes impossible.

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Fourth, the trend developed of dissipating aviation efforts against small-size moving targets dispersed over a wide area instead of concentrating strikes against important targets in order to isolate the battlefield. In this connection the foreign press has noted that "the effectiveness of aircraft operations in the near zone was lower than in the depth of deployment of enemy troops. This was because attacks were dissipated on a multitude of small camouflaged targets, while maneuver near the forward edge of friendly troops was constrained and required the mandatory use of air controllers."*

Fifth, the combined-arms commanders who levied missions on support squadrons did not supply them with reconnaissance data on a real-time basis. The aviation command was forced to conduct reconnaissance "on its own" and to deal with guiding aircraft to assigned targets and with marking the targets.

The timeliness of mission execution. The experience of the war in Vietnam showed a steady trend of reducing the reaction time of attack aircraft to developments in the situation. Support subunits were required to be highly mobile and to take off immediately on call from the forward edge, and flight personnel had to be able to properly clarify and execute a mission received either on the ground or in the air without any prior preparation. Combat conditions demanded not only that aircraft crews find the designated target and have the proper weapons aboard, but also that they deliver the strike at the strictly prescribed time.

As the pace of battle increased strike delivery time was reduced and approached the limits of the technical capabilities of the aircraft. From the point of view of organization, everything possible was done. Solving the problem of reducing reaction time proceeded organizationally by way of providing direct call-up channels (from a ground forces battalion at the forward edge to a ground-attack aircraft base), adopting higher degrees of aircraft alert, preparing and using forward landing fields (or staging airfields), and designating standard flight paths and procedures to the forward edge and back, which flight personnel knew in advance. Combat instructions also provided for the maximum degree of readiness to deliver an attack -- the airborne alert. In practice, however, serious problems arose in connection with flight personnel fatigue. The US command carried out tests of "endurance" in low-level flight. It was discovered that a pilot's attention starts to dull and his reactions to

* Ibid., p. 601.

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slow down after 30 minutes of flight on alert status. This was due to the great physical strain of low-altitude flight and the excessive nervous stress connected with the fatiguing expectation of commitment to battle. Actual reaction time diverged sharply from the planned time that the combined-arms commanders were counting on. After delivering a request for support they usually expected the immediate appearance of aircraft above the forward edge, since a delayed attack did little to help attain the battle's final goal. But pilots could achieve rapid reaction only by being on continuous alert in the zone, and the air force command began to object to that.

Another approach to solving the problem of reducing reaction time and increasing the flexibility and mobility of air support was the idea of extensively using aircraft with vertical (or short) takeoff and landing [VSTOL]. Foreign aviation specialists believe that such aircraft are better in reaction time, rate of operations, survivability, and flexibility of use. This led to basing VSTOL aircraft closer to the front line (up to 50 km) and to setting up direct communications with the combined-arms units that the aviation resources were assigned to and with the direct air support center. Modelling demonstrated that this reduced request reaction time up to 10-11 minutes. Forward basing considerably reduces combat flight time and consequently fuel consumption as well. The support mission rate could therefore be increased to 8-10 flights per day. The small size of VSTOL landing strips (or landing field) makes it easier to camouflage them and provide them with air defense support, which, in combination with the capability of these aircraft to rapidly change flight direction at any altitude for evasive and counter-missile actions, increases their survivability. The combination of vertical takeoff and landing with transonic flight speed provides a VTOL aircraft with the greatest turning rate when attacking a ground target or in close air combat. It is therefore capable of carrying and employing the entire system of air-to-surface and air-to-air munitions used by present-day ground-attack aircraft.

VSTOL aircraft took part in combat operations for the first time in the British Air Force during the Anglo-Argentine conflict and carried out a total of 2,376 combat sorties (including 282 at night). During these sorties they dropped 42 1,000-lb bombs and 21 sub-projectile canisters, and they fired 2,700 shells and 14 air-to-air guided missiles. The majority of flights were made from aircraft carriers under difficult weather conditions. After a beachhead had been established on the island flights were made from a special takeoff and landing strip 245 meters long with aluminum matting. Argentine air defense shot

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down four and damaged one British Sea Harrier VSTOL.* Experience in this armed conflict confirmed the prospects for using VSTOL aircraft from carriers, but added little to develop the concept of using them for air support in a combined-arms battle.

The uninterrupted air support of ground forces combat operations day and night and in any weather was well established as a principle of the combined-arms battle already during World War II and was especially applied during the war in South Vietnam. The combat activities of the patriots increased during the hours of darkness and the rate of air support, on which the aggressor was relying, fell sharply. In this connection the foreign press has noted: "Night deprived the aircraft of all their advantages: it was impossible to determine the location of friendly troops and that of the enemy, who was attacking unseen and determinedly."** One feature of aircraft combat operations at night was that the following measures were considerably complicated or ruled out: group operations (because of violation of safety measures); certain types of attack based on a specific range of target detection and tracking (2.5-5 km in daytime); methods of employing weapons against targets not observed visually; and methods of target acquisition and designation carried out by airborne controllers. Nighttime, which was the faithful ally of the units of Vietnamese patriots, filtered out all the methods of air support and left US aviation with only those had been used in World War II. The illumination of terrain by aerial flares or by searchlights installed in C-130 transports was considered the main form of air support for a nighttime combined-arms battle. The ground forces signalled their position with lamps and illuminated the terrain with bonfires. That these methods were not very effective is shown by the fact that as a result of concealed and sudden attacks the patriots succeeded in burning more than 1,000 US helicopters on the ground.

In the local wars in the Near East and during the conflict in the area of the Falkland (Malvinas) Islands not more than two percent of the total number of air support missions were carried out at nighttime.*** Foreign specialists believe that the problem of nighttime air operations in support of ground forces remains unresolved. Air support has not been able to satisfy one of its main requirements -- that it be carried out without interruption. The troops conducted combat operations around the clock, but this was not within the

* Astronautics and Aeronautics, No. 1, 1983, p. 18.

** Aviation Week, August 1968, p. 26.

*** International Defense Review, No. 2, 1983, p. 135.

capability of aviation, which slackened its efforts with the onset of darkness.

Marked improvement in the effectiveness of air support in a combined-arms battle called for the development of a specially designated aircraft, which was an acute necessity for the aggressor's troops. The original version of the US A-10 ground-attack aircraft was intended solely for daytime operations in a poorly equipped theater of military operations. The decision was later made to adapt it for use in the West European theater of war, which required its technical modification and the development of new operational methods. Great success was expected from the use of lasers to seek targets beyond visual observation range and guide air-to-ground weapons to them.

Three variants have been worked out and tested for attacks using laser guidance: illumination of the target by an infantry spotter (or forward ground post); use of a laser device combining target illumination and designation and mounted in the ground-attack aircraft itself; and illumination of the target from a support (or reconnaissance) aircraft. In practical trials of the effectiveness of these alternatives as measured by the criteria of reliability, simplicity of organization, and adaptability to support conditions, preference was given to the "support aircraft/ground-attack aircraft" system. The results of training exercises demonstrated that by interacting with external laser illumination a pilot can detect a target and determine the heading to it up to a range of about 24 km beyond the limits of nighttime visibility. To determine this, a light reconnaissance aircraft sought out and illuminated a detected target, while a receiver aboard an attack aircraft, by scanning the surface of the earth in various search patterns, found the right laser reflection that carried the appropriate coded signal and ensured that a weapon would home on the target. However, the probability of finding an assigned target under complex ground conditions was not very high.* The forward ground controller operating in the area of the selective search defined the targets and the reference points (control landmarks) and then communicated the data to the air force representative over ground-based shortwave links, and the latter informed the ground-attack aircraft crew in the air over ultrashort-wave links. The pilot reported when he arrived at the control landmark and the ground controller illuminated the target on command of the air force representative, after which guided bombs were launched from the aircraft at a range of up to 7 km from the target.**

* Aerospace International, No. 4, 1977, p. 24.

**Flight, No. 3860, 1983, p. 1149.

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The requirement for uninterrupted air support assumed not only a solution to the problem of improving its effectiveness in night combat but also the assurance of an all-weather capability, which is especially critical in the foggy and rainy conditions of Western Europe. Western specialists are of divided opinion on this point: some support the development of an all-weather ground-attack aircraft, and others want to assign air support missions under difficult weather conditions to existing all-weather fighter-bombers. One of the variants for developing an all-weather ground-attack aircraft calls for modifying the A-10 aircraft by equipping it with radar, a low-altitude TV camera (for use with the Maverick guided missile, which has a TV guidance system), an inertial navigation system, and infrared search equipment. The number of weapons carried is unchanged but a second crew member is added -- an operator to relieve the pilot of part of the burden of target search and control of the aircraft and weapons. The weight of these would increase the already heavy 19-ton A-10 aircraft by another 1,315 kg.

It is assumed that the principal weapon used at night and in bad weather would be the Maverick guided missile, which has a TV homing head and is guided to a target by an aiming-navigation system with night vision that includes a suspended TV system.

Foreign specialists therefore consider that to meet the requirement for uninterrupted air support that is not dependent on time of day or weather conditions they must have an all-weather, but consequently a costly aircraft. It is obvious therefore that the "cost-effectiveness criterion" once more becomes a factor, since above the battlefield the aircraft will be engaged in battle by cheaper antiaircraft weapons, and the costs of a single attack by an aircraft will exceed the value of the destroyed ground target.

Air and ground attacks on the battlefield have been strictly coordinated in local wars by target allocation, establishing the sequence of attacks, designating boundaries of responsibility, and observing safety measures to prevent mutual destruction. This coordination was based on the principle that aircraft would attack those targets which would be difficult or impossible to destroy with ground troops' weapons. The implementation of this principle was predetermined by the capability of tactical aviation to retarget aircraft after they were in flight, and by the organization of reliable monitoring and centralized command and control of all the forces used for support.

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Analysis of joint combat operations conducted in local wars has shown that the operations of ground forces and tactical aviation in the combat zone were always demarcated according to times and boundaries. Ground and air attacks were never simultaneous and were not concentrated in a single limited area. The efforts of artillery, combat helicopters, and other aircraft during close support were diversified as to range. In daytime the boundary of authorized attack by tactical aircraft was close to the forward edge of friendly troops, and in nighttime it was moved back. Sorties of helicopters and other aircraft were echeloned by altitude, and their flight paths were assigned to them by a joint air-traffic control center. Fire support by the forces of tactical aviation, combat helicopters, and artillery was controlled by a schedule of fire that was calculated and coordinated in detail. When providing emergency support, tactical aviation was ensured of a free flight to the target along a corridor within whose boundaries friendly helicopters and artillery did not fire.

In the manual on the combat use of US tactical aviation it states that air support is aimed at achieving three main goals: to reinforce the ground forces' firepower, to render assistance in executing and developing a breakthrough, and to reduce losses of friendly troops to a minimum. In local wars a reduction in firepower was most often observed in the area of operations of combat helicopters, and they were therefore replaced by ground-attack aircraft and fighter-bombers, whose attacks were coordinated with the weapons of the ground forces. Coordination with artillery was sometimes organized solely by boundary lines to which the aircraft flew at medium altitude and above the trajectories of the shells, and past those lines they operated without restrictions. Additionally, antiaircraft weapons that did not have the necessary identification gear were strictly forbidden to fire. In actual practice cooperation between fighters and field air defenses in the same zone proved to be unfeasible.

As noted in the foreign press, the experience gained in local wars in conducting joint combat operations has not shaken the assurance of combined-arms commanders that aircraft must operate closer to the forward edge. Not the least factor here is that troop morale was boosted when air strikes against the enemy were observed from the ground. However, the command of the US Air Force has attempted to withdraw all high-speed attack aircraft from the control of the ground forces and use them deep in enemy territory, and to obtain independence and great freedom of operation under the pretext of improving combat effectiveness. In this regard aviation specialists have written: "Everybody

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recognizes that close support is a complex mission in which the fire of some systems is augmented by the fire of others. When organizing fire coordination, sources of difficulty are the variety and mobility of the targets, the unpredictability of the scenarios, and the abundance of tactical alternatives. When aircraft are forced to operate on the battlefield, their combat capabilities are considerably reduced.*

Thus, the apparently simple task of "being over the target at the designated time and employing the proper weapons" became a problem in actual combat operations. It has not been possible to make tactical aviation a participant in combined-arms combat. Applying a "cost-effectiveness" criterion showed that the results were inadequate and it was necessary to continue the search for new ways of organizing joint operations.

Based on the study of the experience from local wars, as indicated in the US press, the US Army and Air Force produced a memorandum which specified that the Air Force will support operations by deep penetration into enemy territory and the Army is responsible for conducting combat operations up to the depth of 70 km beyond the front line. This division of efforts will have an impact on the elaboration of requirements for the weapons systems planned for deployment up to the year 2000. The memorandum also defines a program of technical cooperation. The Air Force and the Army have agreed: to examine the material base of support in the light of the new requirements; to halt duplication in the production of weapons systems; to concentrate the Army's efforts on short-range weapons systems and those of the Air Force on systems based primarily on cruise missiles and air-launched missiles; and to work out jointly the requirements for ground-based electronic warfare materiel and the systems for aerial reconnaissance conducted in the area of combat operations. All rotary wing aircraft are to remain with the Army and fixed-wing aircraft with the Air Force. Clearly, better accord was specified at the level of developing new equipment and weapons and of defining the optimum ratio between them, but the fixing of the zones of responsibility resulted in the shifting of the line of demarcation deep into enemy territory.**

Considering that fighter-bombers in local wars have used their weapons without Army authorization at the range of 80 km from the forward edge, this means that aviation is permitted relative independence. However, A-10 ground-

* Flight, No. 3253, 1972, p. 78

**Air et Cosmos, No. 22, 1984, p. 22.

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attack aircraft are required to provide assistance to AH-64 Apache attack helicopters, which will be operating over a greater radius during fire support missions. Further work is therefore still required to develop the new type of tactical and fire cooperation between Army and Air Force subunits in the air. Troop exercises held several years ago with the participation of helicopters and ground-attack planes demonstrated that combining them into a single group (to attack a single group of targets) yields better results than employing them separately.*

The foreign press has noted that whereas under conditions in Europe the organization of close support has not been significantly changed, because of the effect of specific weather conditions, the appearance of new weapons, and the increasing threat from field air defenses there have been substantial adjustments made in the tactics of ground-attack aircraft. For example, in the basic variant for support (under normal weather conditions) the A-10 aircraft were armed with a 30-mm cannon that has an effective range of 1,800 meters and Maverick guided missiles that can destroy armored targets up to a range of 7,600 meters, but whose range was limited by the capability for the visual detection of the targets. Given the lethality of the weapons, the following tactical method was worked out for a pair of ground-attack aircraft. After the forward control post guided them to the start-of-maneuver line, one aircraft flew at an altitude of 3,700 meters and used its Maverick guided missiles against self-propelled artillery mounts, while the other continued to fly at an extremely low altitude and attacked tanks by approaching them to the effective range for its cannon fire. On the second pass the roles were reversed. This method was based on a preemptive attack by a guided weapon at long range to paralyze air defense counteractions and ensure the penetration to the target of the attack aircraft. It was noted that the attack itself, which used TV search and guidance, was incompatible with low-altitude flight by a ground-attack aircraft. The pilot's attention was concentrated chiefly on maintaining his height above the ground and he could not divert his attention for very long to the TV screen in the cockpit.**

After flight crews had developed their skills in carrying out the combined method with the change of places, a satisfactory survival rate of ground-attack aircraft was achieved in the zone of simulated antiaircraft fire (much depended on reliable guidance, since the flight of the first aircraft to medium altitude

* Aviation Week, No. 1004, 1984, p. 55.

**Aviation Week, No. 25, 1977, p. 88.

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began right before the moment the pilot acquired the target). However, augmenting the efforts of "enemy" field air defenses with fighters immediately increased the level of losses of ground-attack aircraft. This made it necessary to supplement tactics with methods of waging a defensive air battle. Experiments demonstrated that the optimum variant is for a pair to maneuver at extremely low altitude while covering each other with cannon fire.*

In order to work out the most effective methods for the air support of ground troops under the conditions of the European theater of war, experimental exercises were conducted with the employment of mixed groups of ground-attack aircraft and army attack and reconnaissance helicopters. The mixed group set up for this purpose consisted of four A-10 aircraft, five AH-1G attack helicopters, and four AH-58 reconnaissance helicopters. The "enemy" was represented by 28 tanks, 8 armored vehicles, self-propelled antiaircraft guns, and low-altitude mobile antiaircraft missile systems. The actions of enemy fighters were simulated by an F-5 squadron. The missions of the reconnaissance helicopters and the ground-attack fighters nearly coincided with their primary function, but the attack helicopters had to engage the field air defenses.

The helicopter operations to suppress air defenses were generally based on the element of surprise. The helicopters made a concealed approach to the target by using the cover provided by treetops and after reaching the effective range for launching Tow antitank guided missiles (3,000 meters) they carried out the attack. The flight of ground-attack aircraft used the helicopter flight route for maintaining the direction to the target and determined a target's location by the burst of the missiles. The launch line for the Tow missiles was used for selecting the moment for the first pair of ground-attack aircraft to begin a sharp climb and for the subsequent firing of the Maverick guided missiles. The second pair intensified the attack with cannon fire without first flying to medium altitude. When strong air defense opposition was expected, one of the pairs of ground-attack aircraft stayed in the zone and monitored the attack of the helicopters. If the helicopters were hampered by antiaircraft fire, the pair made a pass to suppress it.

The operating method determined for ground-attack aircraft was a series of brief attacks with no more than 20 seconds in the zone of antiaircraft fire, followed by immediate withdrawal to a fire-free space. The situation with helicopters was more complicated, since their crews had to guide a missile until

* Interavia, 1981, No. 11, pp. 1143.

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the moment it reached the target, and their attacks lasted from 40-45 seconds (which is a period wholly adequate for aimed fire by antiaircraft artillery). A pair of ground-attack aircraft made their run to the target from converging axes at an angle of 20-30 degrees. Analysis has shown that "the best method of stopping tanks is to hit them from the rear and the flanks."

According to data in the foreign press, the effectiveness of air support carried out by mixed groups of aircraft and helicopters was increased by a factor of approximately three in comparison with the previous method. However, this was achieved at the price of extreme stress on the physical capabilities of flight personnel: when used separately ground-attack aircraft carried out four or five sorties per day, but in a mixed group they did not make more than two per day.*

Typically, the alignment of "heterogeneous" forces for a joint attack and the coordination of their operations was feasible only with combined command and control. The Army and Air Force representatives who jointly directed the groups of helicopters and ground-attack aircraft, were stationed in a reconnaissance helicopter fitted out as an airborne command post. All combat support weapons were at their disposal. In the next stage of the experiments it is planned to augment the efforts by ground-attack aircraft and combat helicopters with artillery employing flat-trajectory fire.**

In evaluating the prospects for the development of methods for close air support, the only problems that can be considered solved are those dealing with delimiting the zones of responsibility of the Air Force and the Army and also those of combining their efforts in the development of ground facilities for electronic warfare and systems for aerial reconnaissance of the combat zone. There can also be no doubt that this combat mission will retain its importance and scope.

Along with this, foreign specialists consider that at present the number of unsolved problems is considerably greater. For example, there has still been no selection made of the principal air support weapon of the next generation. Even now the ground-attack aircraft in the inventory of the NATO countries' air forces do not completely meet the requirements for quick reaction, acceptable survivability, all-weather capability, and precision of attack. However, the

* Aviation Week, No. 6, 1978, p. 217.

**Armed Forces Journal, No. 5, 1978, p. 32.

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configuration of the aircraft that is to replace them has still not been determined. The disparity in the European and American concepts is evident in the A-10 (US) and the Alpha Jet and Hawk (FRG and UK) ground-attack aircraft. The European version is a light high-speed aircraft (maximum speed is 930 km/hour) that is capable of "infiltrating" through unsuppressed air defenses under conditions of a relatively equal balance of forces in the air. The US version is a heavy but slower aircraft with more ordnance and is designed for operations when tactical superiority in the air has been secured. Their views are unanimous only in the determination of the "classical" sequence for the performance of the main combat missions: first achieve air superiority, next isolate the area of combat operations, and then provide close air support for the troops.

In connection with the shift of the line of Air Force responsibility beyond the 70-km line and with the development of the concept of the air-land operation (or battle), which assigns the main role to reconnaissance-strike systems and the use of conventional long-range precision weapons, many specialists are inclined to abandon the ground-attack aircraft altogether. A container with submunitions, launched from the ground on a given trajectory and homing on ground targets, can completely replace piloted aircraft, especially when they have the same combat radii.

Results of research have been published in the FRG showing that to destroy a grouping consisting of 600 tanks, 500 armored personnel carriers, 50 artillery batteries, 200 SAMs, and 300 motor vehicles requires about 5,500 aircraft sorties to deliver 33,000 tons of free-fall bombs to the targets. This same mission can be carried out by using submunitions with a total weight of 3,000 tons in 600 combat sorties.*

The new weapons have the advantage in many of the criteria (survivability, accuracy, destructive power) with the exception of one -- cost-effectiveness. But this criterion, as with the choice of an all-weather ground-attack aircraft, may be the decisive one. For example, the US Army and Air Force have decided not to request appropriations prior to 1990 for the Assault Breaker system, the cost of which has increased exorbitantly.**

* Air Force Magazine, No. 9, 1982, p. 36.

**Aviation Week, No. 22, 1984, p. 23.

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Thus, for the next few years air support of ground forces will be carried out by piloted aircraft, but according to a somewhat altered plan. Specialists consider that after the zones of responsibility are defined the best variant is for the independence of ground forces in their own zone, that is, "supremacy" of the helicopter above the battlefield, while tactical attack-aircraft support is forced out beyond the line of demarcation. However, much depends here on whether the new AH-64 Apache attack helicopter is capable of engaging tanks without the cooperation of the A-10 ground-attack aircraft. When conducting joint operations, this assistance is still considered essential.

The role and place of various piloted systems in performing support missions are defined as follows. As an integral part of the ground forces, a helicopter can provide intermittent and highly mobile fire support with a short reaction time; a vertical-takeoff aircraft (based primarily on carriers) has the requisite reaction time and sufficient fire power for amphibious landings; and a ground-attack aircraft, which can be based on dirt airstrips, provides a powerful concentration of fire and has a sufficient diversity of modular ordnance to destroy all types of targets assigned to aviation.

Each airplane or helicopter is presently considered a component of a quite complex and synchronously functioning support system. Requirements for future aviation systems are therefore being worked out in several NATO countries with consideration of the capabilities of other components of the system for the acquisition and processing of information on the air and ground situation, and for guidance, target indication, and the marking of targets and the front line. Today's pilot of a ground-attack aircraft does not operate autonomously in joint operations. The performance of his mission depends on many factors that do not directly involve the characteristics of his aircraft or weapons. A clear example of this is the not yet implemented concept of "forward dispersed bases," even though there is a combat-ready VSTOL aircraft available. In this area difficulties of logistical support have not yet been overcome.

The experience of local wars in which contemporary types of aircraft equipment and weapons have been used has demonstrated that on the whole the requirements for close support of ground troops exceed existing Air Force capabilities. The search for ways of accomplishing this important combat task is continuing.

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